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GENERAL SCIENCE
IN
HIGHER SECONDARY SCHOOLS

STATE INSTITUTE OF EDUCATION
BANIPUR

Reprinted from the Proceedings of the All India Seminar on the Teaching of Science in Higher Secondary Schools.

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CHAPTER IV

SCIENCE IN HIGHER SECONDARY EDUCATION

1. General Science

The teaching of Science at the higher secondary stage has two aspects, one the teaching of General Science as a core subject, compulsory for all students, and secondly the teaching of various branches of Science, such as Physics, Chemistry and Biology as parts of the elective Science group.

The teaching of General Science has as its objectives: (1) to familiarise the pupil with the world in which he lives and to make him understand the impact of Science on society, so as to enable him to adjust himself to his environment. (2) to acquaint him with the scientific method and enable him develop the scientific attitude. (3) to give the pupil a historical perspective, so that he may understand the evolution of scientific development.

Besides fulfilling these aims and objectives, it is essential that the syllabus for General Science should be related to the interest of the different age-groups and everyday life and needs of the community; it should be closely correlated with the local environment; and it should be such as can be adequately dealt with under stipulated conditions, such as available time, staff, equipment, etc.

The Secondary Education Commission in their report have made Mathematics and General Science as one core subject; but this does not appear quite desirable. Grouping them together will lessen the importance and affect instruction in both. Since these two subjects are of equal importance they should be treated as two separate core subjects, and General Science alone should be allotted the following number of periods:

In Class IX	4 periods a week or 141 periods in the year.
In Class X	3 periods a week or 94 periods in the year.
In Class XI	2 periods a week or 75 periods in the year.

making in all 310 periods for General Science spread over a period of three years.

2. Some suggestions for effective teaching of General Science

(1) The concentric method need not be followed within the

higher secondary stage itself, as we deal with students at one stage only, and repetition should be avoided so that interest does not flag. The concentric plan may, however, be followed as we pass from one stage to another.

(2) The evaluation of the work in General Science should be done at the end of each year by the teacher himself for Classes IX, X and XI. At the end of the higher secondary stage, an external examination body will also evaluate the work done during the years by a *viva voce* examination or some other suitable means. Both the internal and external examiners shall each have 50% of the total marks for examination and evaluation of the students.

(3) The teacher should deal with the subject matter in a psychological rather than in a logical order, even if it is not so arranged in the syllabus.

(4) The Draft Syllabus stipulates no work by students in connection with biographies of scientists. Projects on time-charts and case-histories (history of different discoveries and inventions) should be included while dealing with the lives of eminent scientists and inventors.

(5) In order to make the teaching of General Science more effective the number of periods allotted to the Science teacher should not exceed two-thirds of the number of periods allotted to other teachers; in view of the fact that he has to devote much time to prepare himself for laboratory work.

3. Planning the General Science Syllabus

Draft Syllabus prepared by A.I.C.S.E. has been carefully scrutinized and enriched by the addition of more group and outdoor activities (see pages 40 to 59). It now bears greater correlation with life situations and everyday experiences of the pupils. Still many members attending the seminar felt that the syllabus could be replanned to be more in consonance with the environment and experiences of the pupils, in such a way as to bring about a closer integration between the different branches of Science. This could be done through two kinds of approaches (i) Environment-centred and (*ii*) Life-centred, as given below :—

Units Based on Environment-centred Topics

Unit I	... The atmosphere
Unit II	... Water, a vital need of life

Unit III ... The earth surface (geo-economic and physical study)
Unit IV ... Fire and heat
Unit V ... Effects of heating and cooling on air and water
Unit VI ... Study of light
Unit VII ... Civilization and the use of metals
Unit VIII ... Work and energy (the occupations of man)
Unit IX ... Problems of transport and communication
Unit X ... Plants and animals in relation to life
Unit XI ... The study of the body machine
Unit XII ... Understanding overselves
Unit XIII ... Science and philosophy of life (including development of scientific ideas in relation to social philosophy), time chart and case histories

Units Based on Life Topics

Unit I ... World that Science has built
Unit II ... The air we breathe
Unit III ... The water we use
Unit IV ... The food we eat
Unit V ... How man gets his food
Unit VI ... The clothes we wear
Unit VII ... The homes we live in
Unit VIII ... The machines we use
Unit IX ... The power we work with
Unit X ... Protection from disease
Unit XI ... Our biological resourses
Unit XII ... Our mineral resourses
Unit XIII ... Means of transport
Unit XIV ... How we communicate with the world
Unit XV ... The universe we live in
Unit XVI ... Story of life
Unit XVII ... How to be yourself

A syllabus could also be worked out by combining both environment and life-centered topics as has been attempted in New World Science by Burnette, Jaffere and Jim and reproduced below :

Unit I ... The world that Science has built
Unit II ... Your body machine and how it works
Unit III ... Health to you
Unit IV ... Using biological resources for better living
Unit V ... Using mineral resources for better living
Unit VI ... Energy and machines for the world of tomorrow

Unit VII ... Time, measurement and mass production
Unit VIII ... The weather and what we can do about it
Unit IX ... Astronomy: (a) The solar system in which we live
    (b) Billions of stars and other universes
Unit X ... Science for our homes
    A—Heating our homes
    B—Lighting our homes
    C—Electronics in the home
    D—Sound in the home
    E—Science and people

It is regretted that the seminar did not have time to go into this kind of revision of the syllabus in the time at its disposal and replan the units.

6. Syllabus for General Science for Standards IX, X, XI

Course Content	*Demonstrations*	*Experiments*	*Out-Door Activities*
Unit I : *Our Surroundings*			
(*a*) The earth, rocks and soil; different kinds of rocks and minerals.	1 Three classes of rocks. 2 Identification of minerals. 3 Scale of hardness. 4 Making artificial rocks. 5 Identification of fossils.	1 Study of some common rocks ores and minerals. 2 Study of broken rock with a magnifier. 3 Test for limestone. 4 Sand quartz through microscope. 5 Mounting rock and mineral samples. 6 Making a model volcano.	Visit to a rock exposure, rivers, tunnels. Visit to a rock quarry and mines. Collection of minerals and ores.
Formation of soil and its chief constituents ; different kinds of soil, maintaining the fertility of the soil; soil erosion and conservation.	1 Different types of soil. 2 Chief constituents of soil. 3 Soil contains air. 4 Properties of soil particles of different sizes. 5 Difference in fertility. 6 Is a soil acid, alkaline or neutral ? 7 Effect of rain on soil. 8 How to prevent erosin.	1 Making soil from rocks. 2 Effect of soil on growing things. 3 How water rises in fine tubes. 4 How water rises in different types of soil. 5 Making soil productive. 6 Conservation on the school grounds.	Field trip to study erosion of soil. Visit to a hill side. Collection of samples of different types of soils. Observation of insects and worms on soil. *Vana-mahotsava* ; building hedges.

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Course Content	*Demonstrations*	*Experiments*	*Out-Door Activities*
(*b*) *Plants*: different kind of plants; cultivated plants.	1 Plant kingdom. 2 Growth of root-hairs. 3 Roots absorb water. 4 Stems transport liquids. 5 Water transports food for plants. 6 Structure of leaves. 7 What leaves mean to a plant, cholorophyll, photosynthesis. 8 Life cycle of a plant.	1 A simple osmometer. 2 Making leaf collection. 3 Making prints of leaves. 4 Preserving leaf specimens. 5 Green leaves give off oxygen in sunlight. 6 Respiration in a plant. 7 Preparing and using manure.	Visit to a field, an agricultural farm, a botanical or a public garden for observing and collecting plant specimens. Preparing and using of compost (Group project).
Cereals, legumes, vegetables, fruits and ornamental flowers.	1 Crops—how to raise. 2 Meaning of rotation. 3 Structure of seeds. 4 Importance of legumes—root nodules. 5 Controlling enemies of plants-preventive and curative methods. 6 Main parts of a flower.	1 Selecting good seeds. 2 A good seed bed. 3 Raising crops. 4 Identifying common diseases. 5 Collecting and preserving flowers. 6 Male and female flowers. 7 Use of garden tools. 8 Identifying common weeds.	Visits to nurseries. Excursions to places for observing wild flowers. Planting fruit trees (group trees).
Timber trees, medicinal plants.	1 Plants in the service of man. 2 What bark means to a tree. 3 General properties of different kinds of wood. 4 What is in medicinal plants?	Identifying flowers of tree.	Visit to a botanical garden and herbarium. Making a list of common trees around the school and in the district. Collecting medicinal plants. Building cages for keeping ani-
(*c*) *Animals*: general classi-	1 Groups of invertebrates		

fication; domestic and wild animals.	and vertebrates. 2 How long different animals live.		mals, vivarium, aquarium. Visit to a zoological garden and a museum. Excursions to forests, rivers, mountains, and sea for observation and collection of specimens of insects. Classifying the animals existingin home country and outside home country. Study of farm animals and their services to man.
Animals as sources of food, wool and hides ; draught animals and pets.	1 Importance of milk, food, meat, eggs, etc. 2 Common breeds. 3 Sterilization. 4 Signs of health in animals. 5 Examination of animal foods, protein value. 6 Animals add manure to soil. 7 Characters of good animals. 8 Plant-animal relationship.	1 Different systems of keeping poultry. 2 Observing spiders. 3 Caring for frogs. 4 Caring for rats. 5 Building a wormery. 6 Making an incubator. 7 Making an aquarium. 8 Milking a cow.	Visit to a fish hatchery, quarantine and kennels. Poultry keeping (Project).
Insects, useful and harmful. Birds, useful and harmful. Protection of wild life.	1 Classification of insects. 2 Life histories of insects. 3 Life cycle of fruit flies. 4 Life history of a bee, food for bees, worker, queen, drone. 5 Harmful insect.	1 Making an insect-collecting net. 2 Collecting insects, (killing jars and mounting boxes). 3 Identifying common insects. 4 Making an observation nest for ants.	Visit to national parks, Bee-keeping (Project). Destruction of mosquitoes in the area (project).

Course Content	*Demonstrations*	*Experiments*	*Out-Door Activities*
	grasshoppers, locusts, insect pests. 6 Classification of birds. 7 Useful and harmful birds of home country. 8 Stuffing a bird. 9 Balance of nature. 10 Wild-life conservation is necessary for human beings.	5 Examination of mosquito, housefly and bee under magnification. 6 Building a bee-box breeder. 7 What is good and bad in hunting game ? 8 Recording existence of wild life in home country.	
(*d*) *The Universe around us* : sun, planets, moon and stars.	1 Solar system, the sun's family 2 Stars and planets. 3 Identifying heavenly bodies. 4 Telescopes. 5 The sun and what it sends us. 6 Eclipse of the sun. 7 Eclipse of the moon.	1 Making a star map. 2 Making a simple planetarium. 3 Making a chart of constellations of the zodiac. 4 Making a model to show the apparent path of the sun among the stars. 5 Observing visible planets. 6 Making a model of the solar system. 7 Making a telescope. 8 Observing the surface of the moon.	Visits to a planetarium and an observatory. Study of the night sky. Use of telescope.
Seasons and calendar ; tides.	1 The cause of seasons. 2 Equation of time and time diagram. 3 Finding the location and time. 4 Local and Greenwich time	1 Making a simple theodolite or astrolable. 2 Making a simple sextant. 3 Making a sun dial.	Visits to an observatory and oceanographic bureau.

	and date. 5 Clocks and calendar. 6 The moon and the tides. 7 Other minor causes of tides. 8 Foucault pendulum.		
Unit II--*Nature of Things.*			
(*a*) *Air*–The atmosphere around us; the pressure of air.	Demonstration of air pressure.		Study of weather charts from newspapers.
	(*a*) Crushing can experiment. (*b*) Magdeburg's hemispheres. (*c*) Bursting of a balloon. (*d*) Egg and bottle experiment.		Making a toy model wind-mill, parachute; suction of water through straw and eye-dropper.
	2 (*a*) Construction and use of simple barometer. (*b*) Aneroid barometer, barograph.		Visit to a meteorological observatory.
	3 Falling of mercury level of a barometer under a bell jar.		Observation of an elephant sucking water through the trunk; lizards walking on walls and rubber toys that stick by pressure.
			Transferring water from one part of building or field to another (Project).
Syringe.	Construction of a syringe.		Observation of an injection syringe.

Course Content	*Demonstrations*	*Experiments*	*Out-Door Activities*
Siphon	(*a*) Siphon. (*b*) Tantalus cup.	Construction of a siphon, 1 use of a siphon, emptying a liquid from a tin. 2 using a rubber tube as a siphon.	
Pumps.	(*a*) Foot ball inflator. (*b*) Cycle pump. (*c*) Common pump (lift pump). (*d*) Air pump. (*e*) Force pump. (*f*) Fire engine.	Models of a flush tank and water basin.	
Moisture in the air (rain, dew, mist, fog, snow and hail).	Condensation of moisture in the air—wet and dry bulb thermometers.	Recording of variations in the atmospheric pressure-readings of dry and wet bulb thermometers in dry and wet seasons.	Observing wind shields of cars and glass panes during rain. Construction of rain gauge and recording rain-fall (Project).
Composition of air.	Bell jar experiment with yellow phosphorus, candle and iron filings ; lime water test.		Observation of air near factories, in cities and the country side. Observation of lime water and hygroscopic substances exposed to air.
Oxygen and carbondioxide.	Preparation and properties		Making a fire extinguisher

	of oxygen. Preparation and properties of carbondioxide.		(Project). Putting out fire (Project). Observation of giving of oxygen to patients in hospitals.
Burning, breathing, rusting and its prevention (paints); pollution of air and its prevention. Natural cycle of purification of air.			Observation of chimneys and smokeless chulha.
(b) *Water* : Sources of water, storage and distribution. Spring water. Hard and soft water.	Purification of water : filtration, distillation, chlorination. Demonstration of hard and soft water ; removal of hardness of water.	Sedimentation and decantation of muddy water. Use of soap in different kinds of water (before and after boiling).	Visit to water works. Purification of water by filter beds, aeration and chlorination. Use of chlorogen and potassium permanganate. Distribution of water by pumping and gravitation.
Physical properties of liquids. Relative density, Archimedes principle, floatation and hydrometer (functional treatment only).	Pressure of liquids in different directions. Simple hydraulic press. Relative density of a liquid not mixing with water-Hare's apparatus, U-Tube. Archimedes principle. Socket and cylinder experiment. Common hydrometer. Lactometer in pure milk, skimmed milk, diluted skimmed milk.	Determination of safety lines in toy-boats in different liquids. Construction of a hydrometer (test tube float).	Observation of swimming aids, life-belt, tube, banana stem, pitcher. Transport of logs by water. Observation of meteorological balloons and toy balloons.

Course Content	*Demonstrations*	*Experiments*	*Out-Door Activities*
Composition of water-hydrogen and oxygen	Composition of water—electrolysis of water and testing of the gases released. Preparation and properties of hydrogen ; oxy-hydrogen flame.	Verification of porperties of oxygen and hydrogen.	Observation of gas welding.
(c) *Physical and chemical changes.*	Experiments to show physical and chemical changes.		
Mixtures and compounds.	Simple demonstration of mixtures and compounds—sulphur and iron	Separation of constituents of a mixture (such as sand and sugar).	
Separation of mixtures.	Separation of components of mixtures by (*a*) filtration (*b*) distillation—sugar solution, coloured water (*c*) evaporation and crystallisation—saline solution or copper sulphate solution (*d*) sublimation—iodine or ammonium chloride.		Visit to a sugar factory.
Acids andalkalies—their properties, their neutralisation and formation of salts. Sources of common salt.	Identification of an acid, alkali and neutral solution with litmus. Neutralisation of an acid and an alkali.		Testing properties of acids and bases of common use—lemon, vinegar, lime, caustic soda, baking powder, fruit salt. Action of acids like lemon, curds etc. on common household utensils. Ores and metals.

(d) *Metals of common use*—iron, copper, aluminium, zinc, gold, silver, lead, tin; their important properties and uses. Common alloys : brass, bronze, bell metal, german silver, solder, type-metal, stainless steel.	Demonstration of common properties of some metals.		
Non-metals—carbon and coal; kinds of carbon, their uses; products of distillation of coal : their uses.	Absorbing ammonia gas with a piece of carbon. Filtering jaggery solution through animal charcoal.		Collection of non-metals of daily use and listing their uses. Exhibition of products of coal in daily use and preparation of charts.
Sulphur—properties and uses.	Burning sulphur in air; test for sulphur dioxide : litums, potassium permanganate ; bleaching action of sulphur dioxide.		Visit to a vulcanising workshop.
Sulphuric acid : Important properties and uses.	Action of sulphuric acid on metals and on water.		
Phosphorus—red and yellow; important properties and uses.	Physical properties of red and yellow phosphorus ; burning phosphorus in air.		Making crackers.
Chlorine—disinfecting and bleaching properties and uses.	Bleaching action. Preparation of bleaching powder.		

Course Content	*Demonstrations*	*Experiments*	*Out-Door Activities*
(c) *Common things we use*—paper, matches, soap, glass, ink.	Films and film-strips.	Experiments by way of projects.	Visit to match, glass, paper and soap factories.
Uses of sodium carbonate, sodium bicarbonate (washing soda and baking soda), epsom salt, alum, potassium nitrate, copper sulphate, limestone (marble, chalk; fertilizers—natural and artificial; insecticides and disinfectants: phenyle, D.D.T., dettol, lysol, bleaching powder, potassium permanganate, iodine, sulphurdioxide, lime, hydrogen peroxide.		(1) Preparation of matches. (2) Preparation of soap. (3) Preparation of inks. (4) Preparation of paper.	
Unit III—*Energy and Work*:			
(*a*) *Heat*—Sources of heat; sun, fuels, electricity and friction; sun is the prime source of all energy on earth. Heat and temperature. Effects of heat: expansion of solids.	1 Ball and ring experiment. 2 Bar breaking. 3 Expansion of different metals.	Burning paper by using solar energy.	Preparation of a chart showing transformation of energy.

Expansion of liquids.	4 Demonstration of experiments.		Visit to a railway track and an iron bridge. Opening the stopper of a bottle.
Expansion of gases and their applications.	5 Demonstration of experiments.		
Thermometers—simple ideas of different scales; maximum and minimum thermometer; clinical thermometer.	6 Construction and calibration of a thermometer.	1 Relation between the centigrade and fahrenheit scales. 2 Reading a thermometer (including clinical).	Recording maximum-minimum temperatures as part of weather study. Exhibition of charts, models and appliances to show cooling, heating and ventilation. Preparation of a clinical temperature chart.
Heat transmission—conduction, and radiation; their common applications. Domestic heating, air conditioning. Thermos flask.	(*a*) Convection of liquids and gases. (*b*) Conduction, Ingenhausz' apparatus. (*c*) Radiation—demonstration with ether thermoscope. (*d*) Effect of pressure on vapour.		
Melting point, boiling point, specific heat, and qualitative study of latent heat; boiling, evaporation and condensation, simple applications in daily life.	1 Melting point and boiling point of different substances. 2 Preparation of ice by cooling of ether.		Visit to some cold storage plant or ice factory.

Course Content	*Demonstrations*	*Experiments*	*Out-Door Activities*
(*b*) *Light*: Luminous and non-luminous bodies; rectilinear propagation and speed of light; reflection-plane and curved mirrors; periscope, kaeidoscope and their uses.	Experiments to demonstrate plane reflection, formation of images, reflection at concave and convex surfaces.	1 Construction of a pin-hole camera. 2 Construction of a periscope. 3 Construction of a kaleidoscope.	
Refraction through glass and water. Lenses and their uses.	1 Relevant experiments. 2 Formation of images due to refraction through lenses.	1 Observation of refraction and total internal reflection. 2 Identification of convex and concave lenses.	Observation of mirage and twinkling of stars. Observation of apparent depth.
Camera, microscope and telescope; magic lantern, motion picture.	Demonstration of parts and functions of camera and model of the eye; telescope, microscope and projector.		
Prism : colour and rainbow.	Using a prism to demonstrate formation of a spectrum.		Observation of rainbow and halo round the moon.
(*c*) *Sound*: production by a vibrating body; material medium necessary.	1 Pith balls and glass cup. 2 Sonometer. 3 Vibrating tuning fork. 4 Bell jar and electric bell.		
Simple musical instruments-stringed, wind, reed and percussion instruments; Reflec-	1 Demonstration of the model of the ear. 2 Working of sound box of	Preparation of *Ektara* (single stringed) or *Tambura*.	Making a string telephone, flute, etc. Hearing of echoes. Hearing aids.

tion of sound, echo ; how we hear (ear).	a gramophone.		
Toy telephone and phonograph.			Visit to a musical instrument shop.
(*d*) *Magnetism* : natural and artificial ; properties of magnets ; earth as a magnet, magnetic needle and its use for navigation on sea and in air ; mariner's compass.	Mapping the magnetic field of a magnet with iron filings.	1 Magnetising steel strips. 2 Preparation of mariner's compass.	Construction of a magnetic toy.
(*e*) *Electricity*. production : frictional electricity (positive and negative) ; primary cells—voltaic cell, Leclanche cell (wet and dry), storage cells, motor battery (simple treatment of the above).	Demonstration of the parts and working of the cells.	Preparation of a dry cell.	
Alternating and direct currents. Dynamo (very simple treatment). Distribution of electricity, insulators and conductors.	Demonstration of working models.		Making a small electric dynamo and motor.
Effects of electric current : heating, lighting, magnetic and chemical.	Thermal effects and magnetic effects—electric motor, working model of a telegraph.		
Domestic uses of electricity : electric heater, electric iron,	Working of a simple radio set (single valve) and crystal set.	1 Construction of an electromagnet.	Study of a household electric circuit for lighting and for

Course Content	*Demonstrations*	*Experiments*	*Out-Door Activities*
electric lights, electro-magnet, electric bell, electric fan, telegraph, telephone, loudspeaker, microphone and radio.		2 Recording of an electric meter and calculation of units of energy. 3 Replacing a fuse, a switch and plug. Handling of an electric iron, stove and heater. Study of the fan regulator. 4 Electro-plating. 5 Assembling of an electric bell.	power. Visit to electric power house and telephone exchange.
(*f*) *Atomic Energy* : constitution of an atom and production of atmic energy.	Relevant films and filmstrips.		
(*g*) *Simple Machines* : Levers, weighing machines, gears, wheel and axle, pulleys.	Demonstration experiments.		Visit to a machine shop and factory.
Wind and water mills; engines—steam and internal combustion.	Demonstration of working models and sections. Films and filmstrips.		Preparation of charts and models showing application of levers, pulleys, etc. Visit to oil mills, motor workshop and loco-shed. Observation of mechanical toys and Amber charkha.

Unit IV—*Life.*

Living and non-living objects.	Filmstrips to show the characteristics that distinguish the living from the non-living.		
The basis of life : cell, protoplasm and tissues.	Respiration, irritability and movement. Examination of onion peel under the microscope. Examination of staminal hairs of *tradescantia* under the microscope to see the streaming nature of protoplasm. Slides of different kinds of tissues to be shown through the micro-projector.		
Plants and animals : Simple forms of life—bacteria, protozoa and moulds.	Examination of a drop of water by means of a micro-projector.	Examination of bread and other moulds. Examination of a drop of water under a microscope.	
Nutrition in plants and animals. Carbon and nitrogen cycles.	1 Photosynthesis : Evolution of oxygen by plants in sunlight. 2 Formation of starch in a green leaf. 3 Action of saliva on starch.	Experiment to demonstrate the absorption of water from the soil by plant.	Observation of plants in light and shade. Preparation of charts on carbon and nitrogen cycles.
Growth and reproduction in plants. Simple ideas of reproduction in animals includ-	1 Process of cross-pollination by artificial transference of pollen.	1 Recording the growth and change in plants and animals as observed from the school	Visit to an experimental farm, a horticultural garden, and a nursery. Soilless garden-

Course Content	*Demonstrations*	*Experiments*	*Out-Door Activities*
ing man.	2. Showing slides on fertilization by means of microprojector. 3. Vegetative propagation : cutting, grafting and budding. 4. Experiment on conditions of germination. 5. Experiment on conditions of growth. 6. Charts, films and filmstrips showing production in plants and animals.	garden and pond. 2 Sowing seeds of bean, gram and maize. Study of the changes during germination. 3 Germination of pollen grains.	ing and mineral requirements plants. Improvement of variety of plants by artificial cross-pollination (Project).
Sex hygiene.	A few talks by qualified and competent persons.		
Irritability and movement.	Experiments on hydrotropism, geotropism and heliotropism. Experiments on sensitive plants like *mimosa pudica*.	Simple experiments to show curving of roots towards gravity and moisture	Observation and recording of plants that have leaves and flowers that close at night or early morning. Observation of movement of creepers and tendrils towards sunlight and round the support. Withdrawal of snail into its shell and coiling of millipedes on being touched
Changing pattern of life : organic evolution.	Charts, films of fossils.		

Human machine—its needs and care :	Human skeleton, viscera of a goat, sheep or rabbit.	Sketching of human viscera from the model showing the	Making a chart showing comparison of levers with the
(a) *General structure of the human body.*	Charts and models of human viscera.	relative position of the organs.	skeleto-muscular structure of a body.
Digestion.	Action of enzymes on food in aiding digestion : pepsin, renin, bile and pancreatic juices. Films on digestion in man.	Experiment to show the action of cold and hot saliva on starch and in acid and alkaline medium.	
Circulation.	1 Demonstration of the capillary circulation in webbed foot of frog under a microscope. 2 Examination of blood corpuscles by means of a microprojector. 3 Films on blood circulation. 4 Pressure of blood using manometer. 5 Demonstration of pressure points.	1 Examination of the heart of a goat or sheep. 2 Feeling and counting of pulse of persons of different ages and making a record of the same.	Use of tourniquet.
Respiration.	1 Experiments to demonstrate the working of lungs by means of blowing through a glass tube and by bell jar experiment.	1 Examination of the lungs of a goat. 2 Handling a stethoscope :	Artificial respiration.

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Course Content	*Demonstrations*	*Experiments*	*Out-Door Activities*
	2 Charts on deep breathing and artificial respiration.		
Organs of excretion : (a) skin. (b) lungs. (c) kidneys.	(a) Skin : Chart and model of vertical section of skin. (*b*) Lungs : Experiments to show the difference between the carbondioxide content of inspired and expired air by their comparative effect on lime water.	Examination of surface of skin (pores and hair) under a lens.	
Nervous system : brain and spinal cord.	1 Demonstration of sheep's brain. 2 Model of human brain. 3 Reflex action; knee jerks; experiment on decapitated frog.		Charts showing comparison of the nervous system with a telephone exchange.
Sense organs (Important ones) Nose. Eye.	Chart. Box camera. Model of eye and chart showing structure of eye and vision defects. Filmstrips on vision.		Visit to Ear Nose Throat (ENT) clinic and Eye cilinc.
Ear.	Model and chart.		

Human machine.	Charts representing human body as a machine. Human body as thermostat.		
(*b*) *Health and disease* : Common diseases: Common cold and cough, small pox, cholera, dysentery, typhoid, malaria; their causes, spread and prevention.	1 Chart showing droplet infection. 2 Chart of disease-causing bacteria.		Visit to Health Centre. Group Project: Destruction of the mosquito and house-fly in and around the school.
Natural and acquired immunity. Inoculation and vaccination.	3 Charts and specimens of stages of life-history of malarial mosquito and housefly.	Preparing health charts and posters. Planning a health exhibition (Group Project).	Chart of bacteria and their action. Visit to Health Centre.
(*c*)*Food in relation to health.* Different kinds of food.	1 Test for starch, sugar, fat and protein. 2 Chart of vitamins present in different foon-stuffs.	Project : Testing common foodstuffs for their constituents.	Organisation by the pupils of a sanitation camp having a medical unit, a sick room and a First Aid centre.
Value of each kind of food. Balanced diet.	1 Charts showing energy value of common food-stuffs. Charts giving energy requirements of human body.	Project: exhibition on balanced diet for different age-groups	
(*d*) *Personal hygiene* care of teeth, skin, eye and ear.	Chart showing the structure of a normal tooth and a decayed tooth.		Visit to a dental clinic
Need for rest and exercise. Proper habits for the regulation of bowels; correct breathing and posture.	Exercise and posture charts.		

Course Content	*Demonstrations*	*Experiments*	*Out-Door Activities*
Cultivation of good mental health (value of games and other recreational activities.)			
Our special requirements,	1 Pictorial illustrations of various forms of dress through the ages. 2 Relative conduction of heat through different cloth materials. 3 Relative absorption of heat by cloth of different materials and colours	Examination of texture of cotton, wool and silk cloth.	Visit to cloth and woollen mills: to a leather-goods factory.
(*f*) *Social hygiene*: Planning a house, ventilation and lighting cleanliness in the house and surroundings. Village and town sanitation. Methods of purification of drinking water.	1 Charts and models of typical 'Health house". 2 Experiments on convection of gases. 3 Model of a town water supply.	Group Projects : 1 Disinfection of school rooms, lavatories, etc. 2 Purification of drinking water.	Visit to various municipal services.

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1. Unesco Source Book for Science Teaching.
2. Finch, Trewarth and Shearer: "The Earth and its Resources."
3. H.N. Saunders : The Teaching of General Science in Tropical Secondary Schools.
4. E.D. Joseph : The Teaching of Science in Tropical Primary Schools.
5. H. Wells ; Secondary Science Education,
6. Eisman and Tanzer ; Biology and Human Progress.
7. E. Kreeber and W.H. Wolff: Adventures with Animals and Plants.
8. New York State Education Department The General Science Hand Book Parts I and II
9. J.A. Partridge General Science. 2 vols.

2. General Science

EQUIPMENT FOR 40 PUPILS

(a) Apparatus	*Quantity*
Ammeter (D.C.) 10 amps.	1
Balances, physical, 250 gms load, 5 mgms sensitiveness	12
Balance cases for above (glass)	12
Balance demonstration double pointers (1000 g load in glass case with Wt. Box)	1
Balance-platform-working model	1
Balance, spring 1–100 gms	12
Balances, spring (dairy scale), 1000 gms. ...	1
Balances, spring, 50 g–2 kg.	6
Balance, spring, 50 g-4 kg.	1
Ball and ring apparatus.	1
Ball bearings with wheel and axle	36
Balls-pith	6
Balls-pith-on insulating stand	2
Bar compound, iron and brass	1
Bar and gauge	1
Barometer, aneriod-demonstration model ...	1
Barometer, simple, cistern	1
Basins, evaporating-75 mm to 100mm	48
Baths, water, with rings	12
Beakers, Pyrex, 100 cc	24
Beakers, Pyrex, 250 cc	24
Beakers, Pyrex, 400 cc	24
Beakers, Pyrex, tall, 600 cc	6
Bell, electric large	1
Bell, electric small fitted in bell jar	1
Blocks, glass, 10×5×2.5 cm	12
Binoculars	1
Blocks, glass, cube, 2.5 cm	12
Blocks, glass, semicircular, 9 cm	3
Blocks, wood 8×8×4 cm	48
Blowpipes, 20 cm	15
Bobs, pendulum, lead different sizes	20

	Quantity
Borers, cork	8 sets of six
Bottles, S.G. 25 cc.	50
Bottles, cast iron for bursting	6
Bottles, reagent, 250 cc. stoppered	144
Bottles, reagent, 175 cc, stoppered	36
Bottles, reagent, 250 cc, unstoppered, rubber corks	36
Breaking bar apparatus	1
Bow for sonometer	1
Brushes, test tube	24
Burettes, without tap, 50 cc	20
Burette with glass stop-cock	2
Burette stands	24
Burners, Bunsen	20
Calipers, vernier sliding, steel	3
Calipers, vernier sliding wood	6
Calipers, in and outside	12
Calorimeters, complete, copper or steel	10
Camera-box type	1
Cans, overflow	6
Capillarity apparatus	1
Casseroles, 150 cc	2
Cell-Daniell	10
Cell-lead accumulator	6
Cell, Leclanche	6
Charts, wall, human physiology	1 set
Clamps with boss heads	40
Cell-voltaic	1
Clips screw	6
Clips, spring	18
Coils, electrical induction	1 pair.
Coil floating	1
Compass, mariner's model	1
Compasses, pocket	20
Condenser, Liebig, 30 cm (fused glass joints)	12
Conductivity apparatus, Edser's pattern	1
Counter, revolution	1
Covers, gas-jar	48
Crucibles and lids	48
Crucibles, nickle, 25 cc.	12
Crystal wireless receiving set	1
Cubes lcm: cu, brass, al. zn. wood	30

	Quantity
Cube, decimetre, tin.	1
Cylinder and socket	1
Cylinder, graduated, 5 cc	4
Cylinder, graduated, 10 cc	4
Cylinders, graduated, 25 cc	8
Cylinders, graduated, 50 cc	6
Cylinders, graduated, 100 cc	20
Cylinders, graduated, 250 cc	20
Cylinders, graduated, 500 cc	4
Cylinders, graduated 1000 cc	2
Cylinders, metal for specific heat	1 set of five
Cylinders, wood. 4+ 4cm	6
Dessicators, 12 cm	6
Diagrams for chemical lectures: blast furnaces, ammonia soda process, coal gas manufacture, synthetic ammonia, ice plant, aluminium furnace.	2 sets
Diagrams, Wall: maize, sunflower, fungi, mushroom	2 sets
Diagrams, anatomical, wall: rabbit, amoeba, spirogyra, sea-weed, moss, fern, paramecium, hydra, earthworm, cockroach, snail, dogfish, carp, frog, bird.	2 sets
Diamond, writing	1
Disc, Newton's with motor or driving wheel	1
Disc, wood, 10×2 cm	2
Dishes, dissecting	20
Dynamo, working model, A.C.	1
Dynamo, working model, D.C.	1

Electrical accessories

Board-plugs and nuts "Electrano"	72
Connecting links	6 sets
Hexagon lock-nuts	72
Insulating strips	36
Lamp holders	12
Metal strips, 5 cm	72
Metal strips, 2.5 cm	72
Nuts, terminal	72
Pinch plugs	4
Plates, copper, lead zinc (12 each)	36
Plug-board ("Electrano" or others)	2 sets
Rubber pads	72
Series socket	1

	Quantity
Sockets	72
Socket plugs	72
Terminal, telephone	72
Electrical instruments ("Nivocor" similar)	1 set
Electrodes, pt.	1 pair
Electro-magnet, lifting, 6 cm	1
Engine, hot-air	1
Electroplating outfit, copper plating, silver plating, chromium plating, nickel plating	1 set each
Engine-steam-working model	1
Engine, internal combustion, working model	1
First Aid set	1
Flasks, Pyrex, FB 250 cc	24
Flasks, Pyrex, FB 500 cc	24
Flasks, Pyrex, conical 300 cc	20
Flasks, Pyrex, conical 500 cc	6
Flasks, Pyrex, RB 1000 cc	3
Flasks, Pyrex, RB 200 cc	12
Flasks, thermos (one wide-mouthed, one narrow)	2
Forceps, blunt	1 pr.
Forceps, bone	1 pr.
Forceps, sharp	1 pr.
Forceps, stainless, blunt	1 pr.
Forceps, stainless, sharp	1 pr.
Forks, tuning	2 sets of 8
Funnels, filling, glass, small	1 set
Funnels, filter, 7.5 cm	60
Funnels, filter, 10 cm	12
Funnel, filter, 15 cm	6
Funnel, filter, 20 cm	1
Funnels, separating, 100	6
Funnels, thistle, 30 cm	20
Galvanoscope, demonstration type	1
'g' apparatus	1
Gauges, micrometer screw, 10 mm	12
Glasses, watch, 5 cm	40
Glasses, watch, 6.5 cm	40
Heater, immersion, 500 watt	1
Hare's apparatus mounted on stand	6
Human skeleton in glass case	1
Hemispheres, Magdeburg	1 pair

	Quantity
Hydrometers-0.7 to 1	2
Hydrometers-1 to 2	2
Hydrometer, wet and dry bulb	1
Hypsometers,	12
Hygrometer, Regnaults	1
Indicators, Crompton universal, complete	2
Jar, bell, 3 litre (without tubulature)	1
Jar, bell, 3 litre (with tubulature)	1
Jar, bell. open flanged, 18×12 cm	1
Jars, gas, with covers, 20×5 cm	48
Kaleidoscope	1
Keys, plug (electric)	10
Keys, tap (electric)	2
Kipps' apparatus	4
Klinostat (geotropism)	1
Knife, cork	1
Lactometer	1
Lamp, arc	1
Lamp, Davy	1
Lamp, electric, 6 volts	12
Lamp, electric, 230 volts	12
Lantern, projection 15 cm lens with filmstrip and micro-projection attachment and 2 screens	1
Lenses, hand, 25 mm	20
Lenses, double concave, 50 mm, f—20 cm	4
Lenses, double concave, 50 mm, f—30 cm	4
Lenses, double convex, 50 mm, f—10 cm	4
Lenses, double convex, 50 mm, f—5 cm	4
Lenses, double convex, 50 mm, f—20 cm	4
Lenses. double convex, 50 mm, f—30 cm	4
Lenses, double convex, 50 mm, f—50 cm	4
Level-water	1
Magnets, Co-Cr, 5×0.5 cm	20
Lodestone	1
Magnetic needes on stand	12
Magnets, barm Co-Cr, 5×0.5×0.5 cm	2
Magnets, horseshoe, 10 cm	6
Measure, 1000 cc, enamelled	2
Microphone, carbon	1
Microscope, student's type, magnification 500	1
Mirror, cylindrical concave	1

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	Quantity
Mirror, cylindrical convex	1
Mirrors, spherical, concave	6
Mirrors, spherical, convex	6
Mirror strips, plane, 7.5×2.5 cm	20
Morse key	6
Morse sounder	6
Mortars and pestles, 11 cm	10
Motor, (St. Louis) to work on 6 volts	1

(b) Models.

Anatomical models: food canal, lungs, heart and thorax, skin section, eye, jaw and teeth, ear, kidney, head	one each
Babcock boiler and slide-valve steam engine model	1
Force-pump model, glass	1
Lift-pump model, glass	1
Model, :paramecium, hydra, frog skeleton, rabbit skeleton	1 each
Model, circulatory system	1
Model, nervous system	1
Model human viscera	1
Model water mill	1
Model, wind mill	1
Model, periscope	1
Modal, fire engine	1
Needle, dip	1
Needles, dissecting, rustless	40
Opisometers(map measure)	1
Optical demonstration apparatus	1
Oven, heating. 20—110° G with thermostatic control	1
Pascal's apparatus	1
Pints, Winchester, stoppered	24
Pipe, organ, adjustable	1
Pipettes, 1cc	3
Pipettes, 2 cc	3
Pipettes, 5 cc	10
Pipettes, 10 cc	20
Pipettes, 20 cc	20
Pipettes, 25 cc	0
Pipettes, 50 cc	3
Plane, inclined, apparatus with pans	10
Plates. ground glass, 20 cm	2
Prisms, glass, 60°×60°×60°	12

	Quantity
Prisms, glass. 90°×45°×44°	6
Prisms, glass, 90°×50°×33°	3
Prisms, glass 75°×75°×30°	3
Prism, glass, hollow	1
Pulleys, bakelite, single	12
Pulleys, bakelite, double	6
Pulleys. bakelite, treble	6
Pump air, piston, pressure-cun-vacuum	1
Pump filter, cr plated	1
Pump, filter, glass	1
Resistance, sliding, mains	1
Retorts, stoppered, 250 cc	10
Rheostat, sliding, 2A—400 ohm	1
Rods—metre	20
Rods—half meter	20
Sandglass, 1 min	1
Scales, Berranger	1
Scissors, dissecting	20
Screen ground glass, on base	12
Screw-jack apparatus	1
Sieves, various meshes	5
Sieve receiver and cover for above	1
Siphon, simple	1
Siphon, safety	1
Siren	1
Slides, microscope, and cover strips	1 gross
Slides, micro: leaf, stem, root	24
Slide-rule	1
Slit-adjustable on stand	1
Sonometer, complete with accessories	1
Spatulas, horn, 15 cm	20
Spinthariscope	2
Stands, funnnel.	20
Stands, gas jar, stoneware	4
Stands, gas-jar, glass	2
Stands, retort	20
Stands, retort, big	12
Stands, test-tube	24
Stands, tripod	24
Stereoscope	1
Stop-clocks	12

	Quantity
Stove, electric, 1000 watts, 230 volts	1
Syringe, glass	1
Tantalus cup	1
Telephone model	1
Telescope, astronomical	1
Thermometers, 0—100° C×½°	12
Thermometers,—10—110°C×1°	12
Thermometers, 32—220°F×1°	3
Thermometers for filling	10
Thermometer, clinical	1
Thermometers, ungraduated	3
Thermometer, maximum and minimum	1
Thermometer, six's	1
Thermoscope, ether	1
Tiles, square, white, 15×15 cm	20
Tongs, crucible, 20 cm	12
Transformer and rectifier	1
Traps, steam, glass	4
Tray, mercury, 30×30 cm	1
Trays, sand bath	20
Triangles, pipeclay	20
Trough, glass, 25 cm	2
Troughs, (metal)	12
Troughs, stoneware	6
Troughs, mercury, glass, 6 cm	2
Tubes, barometer, straight	3
Tube, gas, 25 cc, with tap	1
Tubes-test, flat-bottomed (20 cm×2 cm)	24
Tubes, test, various sizes	1200
Tubes, U-on stand	6
Tumblers	6
Vacuum-vessel with unsilvered strip	1
Voltameter (0—5 volts)	6
Voltmeter, Hoffman's, on stand	1
Weight boxes (1mg—100 gm)	12
Weighing machine—dial type to weigh up to 1 kgm (10 grm sensitiveness)	1
Weights, fractional	12 sets
Weights, 1/4 oz-2 lb.	1 set
Weights, 1 g—1 kg, brass	1 set
Weights (spare) 0.01—2 g	12 sets

	Quantity
Wheel and axle	1

(c) Tools

Auger bits, for carpenters' braces	5
Blades, hack saw	12
Block, mild steel	1
Brace, carpenter's, with ratchet	1
Bradawals	2
Calipers, inside and outside	2
Chisels, cold	2
Chisels, wood	4
Countersink bits	1 set
Dividers, steel 15 cm	1
Drill, hand, 3-jaw chuck	1
Drills, twist	1 set
Files, different sizes and forms, with handles ...	10
Frame, hack saw	1
Gimlets	2
Glass cutter, diamond	1
Gouge, scribing	1
Grinder and polisher	1
Hammers	2
Lathe, 10 cm centres	1
Mallet, joiners	1
Motor, electric for grinder and polisher ...	1
Oilcan	1
Oilstones, coarse and fine	2
Plane, jack	1
Plane, smoothing	1
Pliers, electrician,s	1 pr.
Punch, centre	1
Rasps	2
Rule, carpenter's folding	1
Rule, steel	1
Saw, bow	1
Saw, panel	1
Saw, tenon	1
Scribers	2
Screw drivers	5
Shearing machine	1
Snips, tinman's	2 pr.

	Quantity
Soldering irons (electrical)	2
Spanners	1 set
Spirit level	1
Spoke shave	1
Square, try, steel	1
Stocks and dies	2 sets
Stone slips for sharping	2
Vice, parallel	1
Vice, woodworker's	1

(d) **General Supplies**

Asbestos, platinized	5g
Catskin	1
Corks, assorted	288
Corks, rubber, assorted	144
Gauzes, copper wire, 10×10 cm	10
Paper, amery, assorted	1 kg
Paper, filter, 9—24 cm	12 pkg
Paper, sand, assorted	1 pkg
Paper, transport squared	1 ream
Parchment, 50 mm	2 m
Pins	144
Rod, ebonite, 20 cm×2 cm	1
Rods, glass, 3—7 mm	3 kg
Rod-glass, 20 cm×2 cm	1
Silk piece, one square foot	1
Spiral, brass wire	1
Tubes, $CaCl_2$, straight	24
Tubes, capillary, glass	1 kg
Tubes, glass, assortment, 3—7 mm	5 kg
Tubes, glass, 25×450 mm	12
Tubes, rubber, various sizes	15 m
Tubes, rubber, pressure	8 m
Tubes, silica	2
Tubes, specimen, 25, 50, 70 and 100 mm	200
Tubes, thick glass, 50×100 mm	12
T-Tubes, glass, 4 and 6 mm	48
U-Tubes, glass, 20×120 mm and 600 mm	30
Wire, copper, bare, 0.5, 0.4, 0.3 mm	1500 g
Wire, nicrome, 0.5 mm and 0.2 mm	100 g
Wire, phosphor bronze, 0.3	100 g

	Quantity
Wire, piano, brass	100 g
Wire, piano, steel	100 g

(e) **Chemicals**

Acetic acid (glacial)	500 g
Acetone	500 g
Alcohol, absolute	0.5 litre
Alcohol, methylated	2.5 litre
Alcohol, rectified	0.5 litre
Aluminium foil, thin	250 g
Aluminium sheet, 0.5 mm	250 g
Aluminium wire, 1 mm	100 g
Alum potash	500 g
Ammonium chloride	20×500 g
Ammonia, 0.910	2 litra
Ammonium molybdate	100 g
Ammonium nitrate	250 g
Ammonium oxalate	500 g
Ammonium sulphate	500 g
Aniline	500 g
Aniline, HCI solution	25 cc
Anthracite	2 kg
Antimony powder	250 g
Arsenious oxide	500 g
Asbestos, mineral, lump	125 g
Asbestos paper	125 g
Asbestos tap, 25 mm	125 g
Asbestos wool	250 g
Barium chloride	500 g
Barium hydroxide	250 g
Benzene	500 g
Bleaching powder	500 g
Borax carmine solution	25 cc
Bromo-phenol blue indicator solution	25 cc
Calcium metal shavings	100 g
Calcium chloride	8×500 g
Calcium oxide	500 g
Calcium nitrate	250 g
Calcium phosphate, di-acid	100 g
Calcium hydroxide	500
Calcium sulphate, pure	250 g

	Quantity
Camphor	100 g
Carbon disulphide	3 kg
Carborundum powder, coarse	100 g
Carborundum powder, fine	100 g
Carmine, finest powder	25 g
Casein, soluble	100 g
Charcoal, animal, granulated	500 g
Chatterton compound	100 g
Chloroform	500 g
Citric acid	250 g
Cloves, oil of	25 g
Coal, bituminous	2 kg
Coal fossils specimen	1
Cobalt chloride	100 g
Congo red, solid	5 g
Copper foil	500 g
Copper, granulated	500 g
Copper acetate	100 g
Copper carbonate	500 g
Copper oxide, tech, powder	500 g
Copper sulphate, crystal	3 kg
Dextrin, pure	100 g
Dextrose	500 g
Dextrose, anhydrous	500 g
p-dichlorobenzene	500 g
D.D.T.	1 kg
Eosin solution	25 cc
Ether, 0.730	500 g
Fellis Bovini extract	25 g
Ferric phosphate soluble	100 g
Fluorescein, soluble	25 g
Formalin	2 litre
Fructose	250 g
Glucose	500 g
Gelatine, sheet	125 g
Glycerine	500 g
Glycine	25 g
Graphite, lump	250 g
Haematoxylin	25 cc
Hydrochloric acid	8 litres
Hydrogen peroxide	250 cc

	Quantity
Invertase	5 g
Iodine	100 g
Iodoform	25 g
Iron filings, coarse	3 kg
Iron filings, fine	3 kg
Iron powder, reduced	500 g
Iron wire	500 g
Iron oxide, magnetic, lump	250 g
Iron sulphide, sticks	20×500 g
Lactase	250 g
Lampblack	500 g
Lead foil	250 g
Lead, gran	500 g
Lead shot	500 g
Lead wire	250 g
Lead acetate	100 g
Lead carbonate	500 g
Lead nitrate	500 g
Lead oxide, powd.	500 g
Lead peroxide	250 gm
Lignite	2 kg
Litmus	100 g
Litmus paper, blue	48 bks
Litmus paper, red	48 bks
Lysol	100 cc
Magnesium ribbon	500 g
Magnesium wire	25 g
Magnesium carbonate	500 g
Magnesium nitrate	250 g
Magnesium sulphate	500 g
Maltose	25 g
Manganese dioxide, powd.	3 kg
Marble chips	1 kg
Mercuric oxide, red	250 g
Mercuric sulphate	25 g
Mercury	3 kg
Methyl violet	25 g
Methylene blue solution	25 cc
Millon's reagent	100 g
Napthalene, marbles	1 kg
α—naphthol	25 g

	Quantity
α—neutral red indicator solution	25 cc
Nickel foil	25 g
Nitric acid	8 litre
Oleic acid	250 g
Oxalic acid	250 g
Palmitic acid	100 g
Pancreas, dried	25 g
Paraffin wax	1 kg
Peat	2 kg
Pepsin granulated	25 g
Phenol red indicator solution	25 cc
Phenyl	1 litre
Phenolphthalein indicator	25 g
Phosphoric acid, sticks	100 g
O-phosphoric acid	250 g
Phosphorus, powder, red	250 g
Phosphorus, yellow	500 g
Plaster of Paris	3 kg
Platinum foil	5 cm^2
Potassium metal in naphtha	25 g
Potassium chlorate	3 kg
Potassium chloride	250 g
Potassium dichromate	500 g
Potassium ferricyanide	500 g
Potassium ferrocyanide	500 g
Potassium hydroxide. pellets	250 g
Potassium iodide	500 g
Potassium nitrate	3 kg
Potassium oxalate	100 g
Potassium permanganate	500 g
Potassium thiocyanate	25 g
Pyrogallol	25 g
Quinine hydrochloride, soluble	10 g
Rock salt, lump	1 kg
Rubber grease	1 tube
Safranin solution	25 cc
Saponin	25 cc
Schultze solution	25 cc
Silicon, lump	100 g
Silver metal	5 g
Silver nitrate	25 g

	Quantity
Soap, soft	500 g
Soda-lime	500 g
Sodium metal in naphtha	250 g
Sodium acetate, anhydrous	250 g
Sodium bicarbonate	1 kg
Sodium carbonate, anhydrous	500 g
Sodium carbonate	3 kg
Sodium chloride	3 kg
Sodium citrate	250 g
Sodium hydrosulphate	100 g
Sodium hydroxide, pellets	1 kg
Sodium hypochlorite, solution	500 g
Sodium phosphate	500 g
Sodium potassium tartarate	500 g
Sodium silicate solution	500 g
Sodium sulphate	250 g
Starch, potato	500 g
Stearic acid	500 g
Steel filings, coarse	500 g
Sucrose	500 g
Sulphur, native mineral	500 g
Sulphur, roll	1 kg
Sulphur, sublimed	1 kg
Sulphur, trioxide tube, specimen	1
Sulphuric acid, 95-98%	10 litre
Tartaric acid	50 g
Thymol	25 g
Tin foil	100 g
Tin, granulated	100 g
Toluene	500 g
Urea	100 g
Vaseline, yellow	500 g
Wax stick	1
Wool, cotton absorbent	500 g
Wool, glass	100 g
Xylene	500 g
Zinc foil	3 kg
Zinc granulated	250 g
Zinc carbonate	250 g
Zinc oxide	500 g
Zinc sulphate	500 g

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8. Laboratory Organisation

The seminar considered the following aspects of laboratory organisation :

(*a*) Lay-out
(*b*) Equipment
(*c*) Administration

(a) Lay-out :

(*i*) A higher secondary school should have one General Science laboratory and three other laboratories for the three elective subjects, *viz.*, Physics, Chemistry and Biology.
(*ii*) Each laboratory should have an over-all floor space of at least 30 sq. ft. per pupil.
(*iii*) Provision should be made for a store room for each laboratory adjacent to it as well as to the class-room.
(*iv*) A portion of the store room may be partitioned off to serve as a preparation room.
(*v*) There should be some suitable place for work-benches with tools in the Science wing.
(*vi*) At least two class rooms with galleried seats should be provided in each school.

(b) Equipment :

The Science class room should have the following equipment :—

(*i*) Galleried seats.
(*ii*) A demonstration table about 8' × 4' with cup-boards, gas and water fittings.
(*iii*) A black-board consisting of a pair of sliding boards.
(*iv*) A white screen for projection.
(*v*) Black curtains for doors, windows and ventilators.

The General Science Laboratory should be equipped with the following :—

(*i*) Ordinary working tables with drawers.
(*ii*) One demonstration table (about 8' × 4') with gas and water fittings.

(*iii*) At least two sinks at the corners of the laboratory.
(*iv*) A wall black board.
(*v*) Stools in 2 sizes.
(*vi*) Almirahs.

The Chemistry Laboratory should have the following equipment :—

(*i*) Working tables with cupboards, shelves, gas and water fittings.
(*ii*) Almirahs.
(*iii*) A separate balance room. In case of smaller schools, projected platforms along the walls should be provided for the balances.
(*iv*) A demonstration table (about 8'×4') with cupboards, gas and water fittings.
(*v*) Wall blackboard.
(*vi*) Two large sinks at the corners of the laboratory.
(*vii*) Draining racks near the sinks.
(*viii*) A fume cupboard.
(*ix*) A wooden box with sand at the bottom for waste materials.
(*x*) Special acid proof drainage system to be provided.
(*xi*) Walls shelve for reagent bottles.

The Physics Laboratory should have the following equipment :—

(*i*) Working tables with recesses underneath.
(*ii*) At least one table with gas fittings for experiments on heat.
(*iii*) Projected platforms preferably along one wall for balances ;
(*iv*) Almirahs ;
(*v*) Demonstration table with drawers, gas and water fittings.
(*vi*) A wall blackboard.
(*vii*) Two large sinks at the corners of the laboratory.
(*viii*) Stools in 2 sizes.

The Physics Laboratory should also have a dark room.

The Biology Laboratory should have the following equipment :—

(*i*) Tables, 6' long 2' wide and 2½' high with water fittings and drawers.
(*ii*) Almirahs.
(*iii*) Two sinks at the corners of the laboratory.
(*iv*) Wall blackboard.
(*v*) Stools in 2 sizes,

(*vi*) Small table racks.
(*vii*) Wall shelves for chemicals.
(*viii*) A froggery, where necessary.

The Biology Laboratory should be well-lighted. It should have glass-panes on the northern side and pendant lights over the tables.

(c) General

The store rooms should be well-equipped with almirahs, racks and a sink. A separate shelter should be provided for inflammable and poisonous materials.

The larger schools should be provided with separate workshop with work benches and a tool cabinet. In smaller schools a few work-benches may be placed in the Science wing.

There should always be a first-aid set and a fire-extinguisher handy near the laboratories.

Provision should be made for an over-head water-reservoir and a gas plant for each school.

(d) Administration

There should be a laboratory attendant for each laboratory with middle school qualifications and two store-keeper-cum laboratory assistants for each school. The store-keeper-cum laboratory assistant should be a matriculate.

Where there is enough work, a mechanic should also be provided for the workshop.

For the teaching of Physics, Chemistry and Biology, there should be at least one double period for each of these for practical work per week.

Experiments should be done as far as possible individually. In any case not more than two students should be grouped together for practical work in the elective Sciences. However, in General Science, groups of three students may be permitted for practical work.

To facilitate practical work, cards with brief instructions should be prepared for each experiment for the use of the students.

It is advisable to have a set of rules for the guidance of the students during their practical work.

Every pupil should maintain a laboratory note-book to record practical work, which should be regularly checked by the teacher.

A date-wise record of experimental work done by each pupil should be maintained by the teacher in the form of a chart.

9. Teaching Aids

The use of the following types of teaching aids is essential :

(*a*) *Charts, diagrams, sketches and models. Some charts, diagrams, models slides may be purchased, but most of them should be got prepared by the students. It is suggested that*

- (*i*) the teacher should outline a plan of the visual-aids to be prepared during the year. He should then assign the work to different groups of students.
- (*ii*) the work should be distributed over the whole year.
- (*iii*) opportunity should be given to every pupil to participate in the preparation of these aids.
- (*iv*) the teaching aids thus prepared should be properly displayad.

(*b*) *Collection of Illustrative Material of a Scientific Nature*

- (*i*) the teacher should encourage individual students to collect material of scientific interest representing the different branches of Science.
- (*ii*) the pupils should properly label the material collected.
- (*iii*) these should be kept in the Science Museum and used as teaching aids when required.

(*c*) *Hand-made Apparatus*

The making of some apparatus in the laboratory with the material available has considerable educational value for the students. At the same time, some good aids to teaching can thus be prepared at a nominal cost. For this reasons it is suggested that :

- (*i*) the students be encouraged to make some simple apparatus in the laboratory workshop.
- (*ii*) the school should supply the materials required.

(*d*) *Museum, Aquarium and Vivarium*

The museum, aquarium and vivarium not only have things of considerable scientific interest which can be used as aids to teaching, but create a scientific atmosphere about the school. It is suggested that :

- (*i*) every school should have a museum with provision for a Science section.
- (*ii*) there should be show-cases in which the articles collected or made by the students are preserved and displayed.
- (*iii*) every year there should be some additions to the museum and old and worn out articles should be replaced.

(*e*) *Nature Study Garden*

- (*i*) there should be a nature study garden in the school.
- (*ii*) as far as possible, the nature study garden should be maintained by the students.
- (*iii*) there should be a pond in the garden.
- (*iv*) where a nature study garden cannot be provided there should be pot plants for use in teaching Botany and General Science.

(*f*) *Excursions and Visits to places of scientific interest*

- (*i*) there should be at least one excursion a year to a place of scientific interest.
- (*ii*) visits to local places of scientific interest should be arranged as frequently as possible.
- (*iii*) the teacher, in co-operation with the students should make a plan to make the excursion or visit as educative as possible.
- (*iv*) adequate funds should be provided for the excursions and visits.

(*g*) *Audio-visual Aids, such as films, filmstrips and slides*

In order that effective use may be made of the appropriate films, filmstrips and slides :

- (*i*) every school should have an epidiascope and a filmstrips projector or an epidiascope with filmstrip attachment ;
- (*ii*) in bigger schools, it is advisable to have a 16 mm. sound projector ;
- (*iii*) there should be a state library of films, filmstrips and slides which should be available to schools on loan ;
- (*iv*) the education department may have a mobile regional audio-visual-aids-service unit with 16 mm. sound projector and other equipment to meet the needs of the smaller schools.

(*h*) *Science Broadcasts*

To make the radio broadcasts more useful as aids to the teaching of Science :

(*i*) the All-India Radio should include a larger number of talks on scientific topics useful for students and Science teachers should also be associated with the preparation of the broadcasts. Tape recordings of such broadcasts should be made available to schools on request by All-India Radio ;

(*ii*) a radio set should be provided to each school to enable the students to listen to educational broadcasts ;

(*iii*) provision should be made in the time-table for the pupils to listen to these broadcasts in consultation with the A.I.R. authorities ;

(*iv*) the Science teacher may refer to such broadcasts in his teaching where necessary.

(*i*) *Exhibitions and Science Fairs*

(*i*) efforts should be made to hold an annual Science exhibition or fair in the school.

(*ii*) the Science exhibition or fair should be the product of the co-operative efforts of the teachers and the students.

(*iii*) as a follow-up of the Science exhibition or fair, discussions should be held among the students on the exhibits and experiments shown.

11. Science Clubs

Every school must have a Science club. These clubs are of the pupils by the pupils and for the pupils.

Purpose

The following are some of the aims of Science club :

1. to inculcate a scientific attitude in the pupils.
2. to encourge the pursuit of Science as a hobby.
3. to stimulate pupil-participation and intiative in learning Science.
4. to encourage pupils to take an intelligent interest in the environment and every-day experiences.
5. to encourage individual and group initiative.
6. to contact other Science clubs and to exchange information and activities.
7. to aim at a regional, leading to wider affiliation on state, national and international levels.

Organisation

1. The Science teacher, normally, will sponsor the club.
2. The head of the school should be a patron of the club.
3. Membership should be open to all pupils studying Science and others interested in Science.
4. The resources of the school should be available to the club.
5. An elected executive committee should be formed from among the pupils—a chairman, a secretary, an assistant secretary, a treasurer, a librarian, a store-keeper, a publicity officer and class representatives.
6. A nominal membership fee should be charged from all the members.
7. The club should tap other resources also.
8. The club should be located in the school.
9. The members of the club may be encouraged to extend the activities of the club in their own locality.
10. The duties of the patron, sponsor and office-bearers should be:

Patron : To extend all facilities to the club to function effectively and to co-operate in its activities.

Sponsor : On the sponsor devolves the initiative in starting the club and keeping it at a high pitch of activity and interest. The sponsor should only supervise, guide and lead and should not instruct or dictate. He should be watchful over the members and guard them against accidents.

Chairman : to preside over all the formal functions of the club and over the meetings of the executive committee.

Secretary : to maintain the minutes of meetings and the activities of the club ; to carry on correspondence; invite guests.

Assistant Secretary : to assist the secretary and to act for him in his absence.

Treasurer : to collect subscription and maintain accounts of receipts and expenditure.

Librarian : to maintain a catalogue of the library, to issue and receive books, to purchase books sanctioned by the executive committee; file and keep a record of the papers written by the members of the club.

Store Keeper : to maintain a record of the equipment of the club, to buy new equipment sanctioned by the executive committee.

Publicity Officer : to publicise the activities of the club within and without the school; to contact newspapers and seek wide publicity for the activities of the club, is meetings, its magazines, its celebrations (exhibition, fair etc.).

Members : to participate actively in the meetings of the executive committee, in framing policies, to enlist the co-operation of the members of the class and to enlist new members.

Suggested Activities

The following are some of the activities that should be undertaken by a Science club.

1. arrange excursions, visits to places of interest, etc.
2. hold Science exhibitions and fairs.
3. conduct the meteorological section of the school.
4. hold discussion,s meetings and debates.
5. to read papers on individual or group work done,

6. to collect specimens, prepare models, charts, exhibits and maintain a scrap book.
7. to improvise and prepare hand-made apparatus.
8. to improvise experiments.
9. to celebrate Science days and put up tableaux, plays.
10. to hold meetings addressed by invited guests.
11. to render school service in health and sanitation.
12. to render community service in the realm of public health.
13. to organise drives to inculcate sound health habits.
14. to attempt to eradicate superstition and age-old taboos.

All India Association of Science Clubs

In view of the importance of the Science Club activities as outlined above, an All India Association of Science Clubs, should be formed under the auspices of the A.I.C.S.E.

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